

## **Jim Gatheral: The volatility surface, a practitioner's guide**

**ISBN 0-471-79251-9, Wiley (2006), 179 pages, approx. 100 CHF**

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Published online: 10 January 2008

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Gatheral's book *The Volatility Surface* is subtitled *A Practitioner's Guide*, but beware! The practitioner for whom the book is meant is one with a mathematical finance background. If you are not interested in an applied mathematical treatment, read no further, as this book will not be to your liking. The book originates in lecture notes from a course the author taught at New York University. For the most part, the author follows the original sources of option pricing theory closely, sometimes line by line. The added value of the exposition is from aggregating these and directing the reader to the implications for modeling the volatility surface. Mathematical rigor is not stressed in the presentation as the target audience for the book is expected to already be familiar with option pricing well beyond Black-Scholes and also knowledgeable of the relevant tools from stochastic calculus, partial differential equations, and functional analysis, such as characteristic functions. One of the main topics in the book is a comparison of the Heston (1993) model and extensions of it that include jumps with local volatility models in terms of the volatility surface of equity options. Similarities of the models when pricing plain-vanilla options and the different implications for the dynamics of the volatility skew are discussed at several points. The author employs mostly heuristic arguments and analytical relationships between the models; the latter are sometimes derived from approximations or with limit arguments.

The unique feature of Gatheral's treatment of the subject is its brevity and the author's focus on using analytic relationships to make his points. For example, Rebbonato's *Volatility and Correlation* (2<sup>nd</sup> ed., 2004) has 836 pages; Gatheral's book has 179. Naturally, Rebbonato's book covers more topics, including equity and fixed

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income dynamics and many general empirical relationships, whereas Gatheral's book focuses on the implications of modeling equity volatility surfaces.

The author sets up the theoretical framework in the first five chapters, starting with a definition of local variance and relating it to implied and instantaneous variances. The second chapter introduces the Heston model. Chapter 3 further elaborates on the relationship between local, implied, and instantaneous variance, resulting in an operationalized representation that is used in the fourth chapter to compare local and stochastic volatility models for a specific parameter set of the Heston model. This first part of the book concludes, in Chapter 5, with heuristic empirical arguments making a case for including jumps when modeling the underlying. The next part of the book has a more "applied" nature, but still relies heavily on analytic representations.

Chapter 6 deals with simplistic models on credit risk and illustrates the effect of credit spreads on the volatility skew. In Chapters 7 and 8, the author reverts to his main topic of comparing stochastic and local volatility models. His insight is that while the shape of the volatility surface can be reproduced by many models, the implicit dynamics resulting from local volatility models are unrealistic. These results are applied to barrier options and exotic forward-starting options to illustrate the previous sections. The final chapter deals with pricing volatility derivatives, which are increasingly popular with market participants. Gatheral reviews the analytic formulas for the valuation of volatility and variance swaps and briefly discusses hedging issues.

What I found lacking in this book are further references, especially in the empirical and credit risk sections. I realize that providing a comprehensive literature review is not the purpose of Gatheral's book and certainly would have increased its length; however, a brief paragraph at the end of each chapter citing additional relevant literature would have gone a long way toward providing the reader with more of a reference book on volatility surface models. Overall, this book will not replace the stack of papers the reader has likely already compiled on the subject. Even so, I do recommend this book to those familiar with its topic and who want to refresh their knowledge of or look up economic implications and implementation issues regarding various models for the volatility surface.